MARINE
NATIONAL FACILITY

2013 program

RV *Southern Surveyor*

CSIRO

voyage summary SS2013_v01

SS2013_v01

Voyage: Submarine landslides offshore northern New South Wales and southern Queensland: their geomechanical characteristics, timing and triggers

Voyage period
Start: 17/01/2013
End: 04/02/2013
Port of departure: Brisbane, Australia
Port of return: Brisbane, Australia

Responsible laboratory
School of Geosciences – The University of Sydney
NSW 2006, Australia

Chief Scientist
Associate Professor Tom Hubble
School of Geosciences – The University of Sydney
NSW 2006, Australia

Scientific Objectives

An extensive region of the continental slope located offshore Northern New South Wales and Southern Queensland between Byron Bay and Noosa Heads was demonstrated to have experienced intense submarine erosion dominated by submarine landsliding in 2008 (ss12/2008, Boyd, Keene, Gardner, Exon, Hubble et al.). Major questions about the geographic extent of the area affected by these processes, the geomechanics and dynamics of sliding; the timing and frequency of sliding; and the potential trigger mechanism for slide initiation have arisen from the analysis of the material collected by the scientists who participated in the ss12/2008 voyage. These workers and their colleagues (Hubble, Airey, Clarke, Yu, Keene, Boyd et al.) have demonstrated that submarine landsliding on Eastern Australia's continental margin is unexpectedly young and frequent at geological timescales. They have also developed geological and geotechnical models which attempt to explain the apparent youth and unexpected frequency of submarine landsliding in this area of the Eastern Australian continental margin.

This project was designed to extend the findings of the ss12/2008 voyage by collecting additional core and dredge samples in the original study area and by extending the coverage of detailed seafloor bathymetry to the north of the 2008 study area as well as by sampling appropriate features in the newly mapped area. This data that will help to validate or modify the models developed to explain the areas submarine erosion and landsliding developed since the ss12/2008 voyage.

Voyage Objectives

1) Extend the area of detailed bathymetric mapping of the outer continental shelf and continental slope to the north of the ss12/2008 survey area offshore Fraser Island and identify further submarine landslides and erosional features such as failure scars and scarps. Included in this objective were two specific targets, these were to:

   a) determine the specific location and characterization of the site (or possible sites) from which an enormous olistostromic block was shed with the intent of establishing the trajectory of this slide block and the dynamics of its motion in this area – the general location that this block will have been derived from offshore the southern third of Fraser Island; and

   b) connect the heads of canyons to outer shelf sand-bodies that are suspected to be cascading downslope and contribute to incising the canyons and/or abrading and modifying the slope morphology (e.g. near the southern boundary of the Fraser Island swath map area).

2) Collect geological and geotechnical samples (core and dredge) offshore Fraser Island to enlarge the geological material available for geotechnical testing and dating.

3) Collect cores and dredge samples from the ss12/2008 survey area to improve our knowledge about the frequency of submarine landslides (dating) and the landslide processes (geotechnical samples).

   Additional undisturbed material from currently identified but as yet not sampled slides will be used to better characterise the timing of failure and the causes, mechanics and dynamics of sliding so that the influence of the two more-likely suggested causal factors for sliding (lowered sea-level and earthquake shaking) can be assessed.

Results

1) This objective was met with a high degree of success. The continental slope between 200 m water depth and the abyssal plain was mapped to the east the Queensland coast between Caloundra in the south and the northern tip of Fraser Island. The mapped area is approximately five thousand square kilometres in extent (200 km long, north to south by 25km wide, east to west) and provides data appropriate to satisfying objectives 1a) and 1b) described above; that is a) identifying potential source sites for the known giant slide block and b) investigating shelf to canyon transport mechanisms – particularly the delivery of shelf sediments to the Noosa Canyons.

   In addition to the seafloor mapping offshore Fraser Island swath mapping was undertaken during transit legs to the Yamba and Byron Bay Area which extended the mapped seafloor coverage of an area to the east and south of the SS12/2008 voyage. In particular the middle continental slope in a region offshore Yamba was mapped in order to contextualise the subsurface submarine landslide structures evident in a high-quality deep seismic reflection line acquired by Geoscience Australia in the mid-1990's.

2) This objective was met with a very high degree of success. Thirty-four attempts to recover geological and geotechnical samples were made offshore Fraser Island of which 15 were gravity cores (all successful) and 18 were dredge hauls (16 successful) one unsuccessful grab sample was also attempted.

3) This objective was met with a very high degree of success. Twenty-nine additional attempts to recover geological and geotechnical samples were made in the ss12/2008 area between the Noosa Canyons and Yamba of which 24 were gravity cores (17 successful) and 6 were dredge hauls (all successful). Coring in the Yamba Slides and Byron Bay Slide was particularly successful and a large number of submarine landslide surfaces (at least five and possibly many more – not all cores were split on board) are thought to have been sampled.

Voyage Narrative

Leg One – day one to day three

18th of January 2013 to the 21st of January 2013
Swath Mapping of Barwon Bank and the Continental Slope
Between Caloundra and the Northern Tip of Fraser Island

Embarked Port of Brisbane 8 am, 18th Jan
Arrived Caloundra Pilot Station 2 pm,
Commenced Scientific Operations 5 pm

Operating Conditions

The sea-state was generally very good throughout this period of the voyage with fine weather and light to moderate winds. Strong northerly currents (between two and three knots) which set ship to the south were experienced during the northerly and southerly bathymetric survey legs offshore Fraser Island. These strong currents remained active throughout the voyage.

Scientific Operations

Swath Mapping with the multibeam system and sub-bottom profiling with the Topas system of the Barwon Bank sedimentary deposits.

The sea-state was generally very good throughout this period of the voyage with fine weather and light to moderate winds. Strong northerly currents (between two and three knots) which set ship to the south were experienced during the northerly and southerly bathymetric survey legs offshore Fraser Island. These strong currents remained active throughout the voyage.

Achieved Targets

1) Bathymetric mapping and sub-bottom profiling of the Barwon Bank complex. Survey Lines 1 to 8 on the adjacent Map – survey commenced at approximately 3 pm on day one and was completed at approximately midnight on day One.

2) Swath-mapping east of Fraser Island in northerly and southerly directions in the area delineated by the yellow lines on the adjacent map (Figure One).

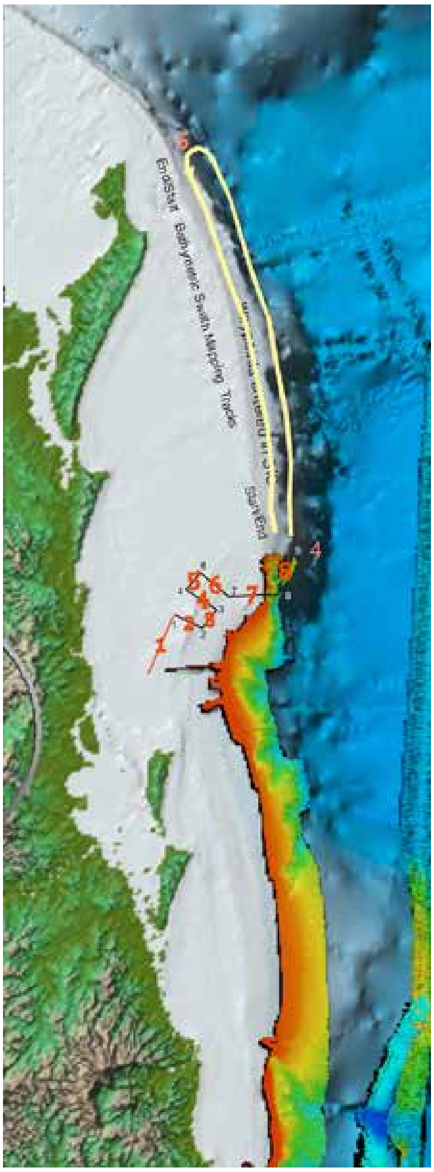


Figure 1

Leg Two – day four to day eight

22nd of January 2013 to the 25th of January 2013
Coring and Dredging Operations – Indian Head to Wide Bay Canyons
Swath Mapping Lower Continental Slope

Operating Conditions

The sea-state was generally very good (Beaufort Three) at the beginning of this period of the voyage but the influence of the 'coast-hugging' ex-Cyclone Oswald was becoming increasingly evident as it moved south from northern Queensland towards our study area during days six and seven. By the end of day seven conditions had deteriorated to a Beaufort Six/Seven sea state and sampling operations ceased as conditions deteriorated and to the extent that it was no longer possible to safely deploy the coring equipment or dredges. Strong northerly currents (between two and three knots) which set ship to the south continued during this period.

Scientific Operations

Given that the weather and sea-state would worsen through days six and seven the focus of the scientific operations was changed to the collection of core and dredge samples in this northern portion of the project's study area. By the beginning of day four sufficient multibeam data had been acquired to enable good sampling targets to be identified on the upper and middle continental slope. The operational strategy employed was dredging and coring operations were undertaken during an extended working day (8 am to midnight) followed by appropriate swath-mapping to either connect well-understood shelf-sediment systems to the upper slope (e.g. Gardner Bank) or to map the canyon heads and shelf-edge (e.g. Wide Bay Canyon).

Achieved Targets

1) Coring and dredging of slides and scarps in the Fraser Island Canyon Complex (black dashed box, Figure Two).

2) Swath mapping and sub-bottom profiling of the Gardner Bank Area (white boxed area, Figure Two)

3) Coring and dredging of slides and scarps to the north and south of the Wide Bay Canyon and coring in the axis of the Wide Bay Canyon (black boxed area, Figure Two).

4) Bathymetric mapping and sub-bottom profiling of lower slope and mouth of the Wide Bay Canyon the Barwon Bank complex (white dashed box area, Figure Two).

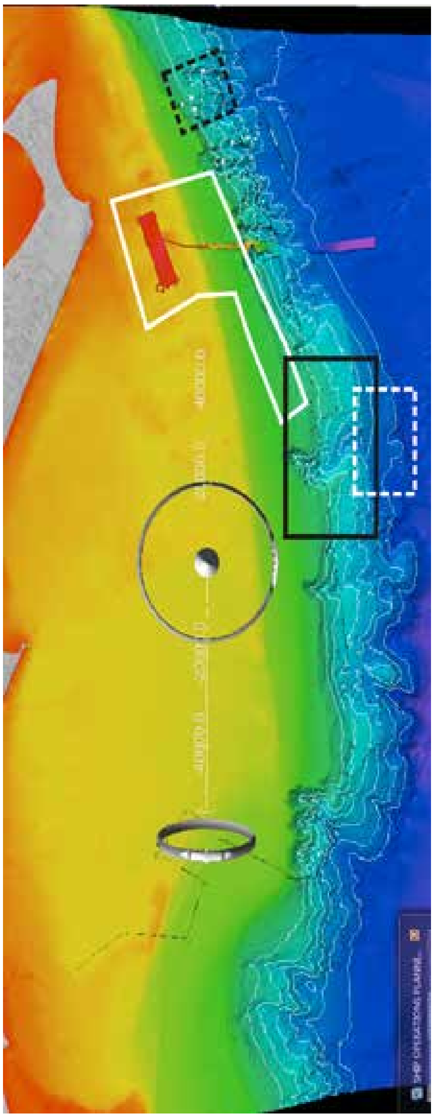


Figure 2

Leg Three – day nine to day eleven

25th of January 2013 to the 28th of January 2013
Swath Mapping Middle and Lower Slope – Noosa Canyon Area and Wide Bay Area

Operating Conditions

The sea-state was generally poor to bad (Beaufort Seven and Eight) and relatively unpleasant during this period due to the persistence and intensification of the 'coast-hugging' ex-Cyclone Oswald. This tropical storm caused widespread flooding and a one-metre storm surge throughout southern Queensland some 50 nautical miles or so to our west and even triggered coastal tornadoes near Bundaberg.

Oswald was quite disruptive to the scientific operations and required that the ship decrease speed to three knots and 'heave-to' in order to ride out the worst of the weather. The swell was at its largest during day nine and was between seven and eight metres at worst of the weather. The strong northerly currents (between two and three knots) which set ship to the south continued during this period.

Scientific Operations

In view of the arrival of poor weather conditions and the requirement of a NNE or SSW course to provide relative comfort for the scientists and crew it was only possible to swath-map with the multi-beam system. Initially this was undertaken in an area offshore from Caloundra while we waited for the storm to head east across the Tasman, subsequently we steamed north through the edge of the storm to map an area of the lower slope offshore central Fraser Island to be followed by an area of the lower slope to the north of the Wide Bay Canyon.

Achieved Targets

1) Bathymetric mapping of lower slope to the north of the Noosa Canyons offshore Caloundra, the southerly boxed area (solid white line) shown in Figure Three.

2) Bathymetric mapping of lower slope offshore central Fraser Island near the mouth of the Wide Bay Canyon, the central boxed area (dashed white line) shown in Figure Three.

3) Bathymetric mapping of lower slope to the north of the mouth of Wide Bay Canyon the northern boxed area (dotted white line) shown in Figure Three.

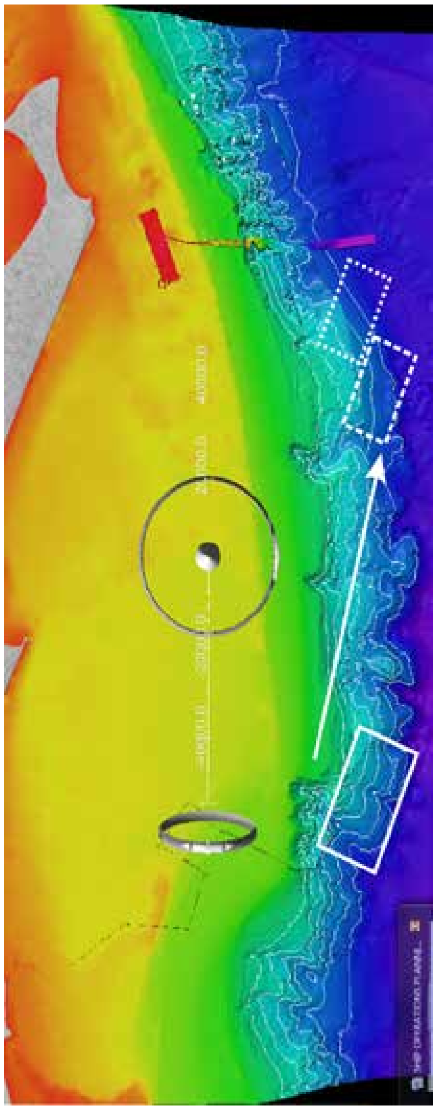


Figure 3

Leg Four – days twelve and thirteen

30th of January 2013 and 31st of January 2013
Coring and Dredging Operations Noosa Canyon Complex
Transit to Yamba

Operating Conditions

The sea-state began to improve towards the end of day eleven to a Beaufort 3 to 4 as the wind backed away into the north-west and the barometer gradually rose. It was possible to increase the ships speed gradually back to normal operating speed of 10 knots through the water by the late-afternoon of day twelve with no restriction on the heading although NNE and SSW was more comfortable. We returned to the south to recommence the planned sampling program in the southern half of the project area. The swell gradually dropped throughout this time but a constant, moderate swell persisted as a challenge to sampling. The three metre swell dominantly approached the coast from the east but with a cross-swell from the south. These calmer conditions were more favourable to scientific operations and enabled a transit back to the Noosa Canyons offshore Caloundra and the sampling program recommenced.

Scientific Operations

Completion of the shelf-bathymetry mapping and dredging of the continental slope materials to the north and south of Noosa Canyon and coring in the axis of the Noosa Canyons (white boxed area shown in Figure Four). These operations were followed by a southerly transit to sites offshore Yamba in northern New South Wales.

Achieved Targets

1) Bathymetric Mapping of shelf and upper slope adjacent to the Noosa Canyon complex directly offshore Caloundra.

2) Dredging of the upper continental slope materials from the crests of slump scars evident to the north and south of the Noosa canyons

3) Coring of the Noosa Canyon Axis.

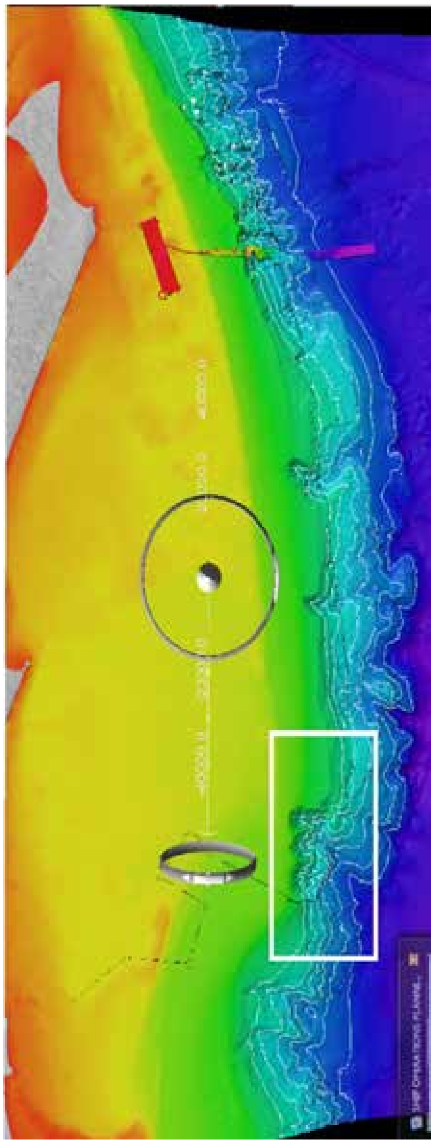


Figure 4

Leg Five – days fourteen to seventeen and disembarkation

1st of February 2013 to 4th of February 2013
Coring and Dredging Operations Yamba to Tweed Canyon and Barwon Bank
Transit to Barwon Bank and then transit to Brisbane Pilot and Voyage Completion

Operating Conditions

The weather during this final part of the voyage was generally good and condusive to the full range of ship's operations. Skies were generally clear or moderately cloudy with light to moderate northerly and NNE winds of up to 20 knots. This produced sea- states between Beaufort 3 and 4 but the swell remained moderate for the remainder of the voyage with brief large 3 metre swell sets from the east and the south rising above the general 2 metre swells producing a somewhat confused swell. Stronger than usual northerly currents (between three and four knots) were experienced during this leg of the voyage.

Scientific Operations

This final section of the voyage was particularly productive and contributed greatly to achieving one of the voyages objectives of collecting cores from the upper continental slope's landslides. A significant number of these cores demonstrably penetrated recently deposited sediment drapes and accessed older compacted material from suspected landslide surfaces in the Yamba Area and Byron Slide. After completion of this sampling and the transit back to Brisbane against very strong southerly currents there was still some time available which was used by sampling and sub-bottom profiling the Barwon Bank feature after which we met the Brisbane Pilot at 6am.

Achieved Targets

1) Bathymetric mapping of the middle and upper slope offshore Yamba. This additional surveying to the south of the SS 2008-V01 survey area provides bathymetric context for a high quality seismic reflection survey undertaken by Geoscience Australia in the 1990's – a number of submarine landslide features are evident in this data (white dashed box area, Figure Five)

2) Coring of the Yamba Slide Complex (4); upper slope slides between Yamba and Clarence Canyon (10) and in the Clarence (1) and the Byron Slide (4) complexes, as well as dredging of the lower Byron Slide (1) (White Box area, Figure Five)

3) Confirmed the location of wreck of the MV *Limerick* which was sunk by a Japanese submarine in World War Two.

4) Bathymetric mapping, Topas profiling and sampling of the Barwon Bank Complex (Black Boxed area, Figure Five).

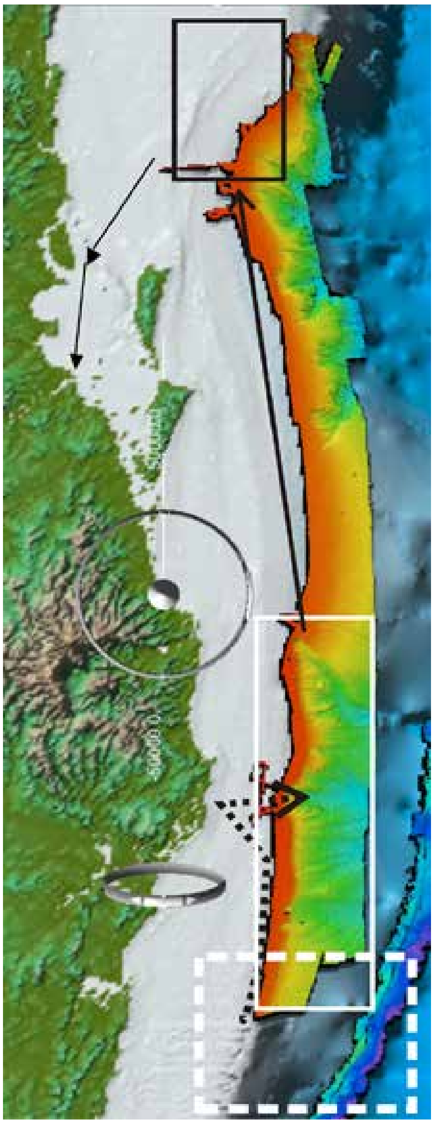


Figure 5

Summary

The *Southern Surveyor* research voyage, ss2013_v01 collected regional bathymetric data for the seabed of the continental margin and slope of southern Queensland in a region bounded by Caloundra in the south and Indian Head, Fraser Island in the north. The newly mapped area presents a particularly steep portion of continental slope which is dissected by three large submarine canyons offshore northern Fraser Island, Wide Bay and Caloundra (i.e. the Fraser Canyons, the Wide Bay Canyon and the Noosa Canyons). Dredge and core samples have been collected from the northern, central and southern areas of the bathymetric survey area's continental slope and from the central axes of the Wide Bay and Noosa canyons. The initial examination of these three sets of data indicate that the area has been subject to several large submarine slides and is currently subject to active canyon incision, as well as experiencing currently active mass gravity flow (turbidite-style) sedimentary processes. It is apparent from the morphology of this portion of the continental slope that the large, landslide block thought to have been generated from a site located near the south of Fraser Island was more likely to have been shed from this slope in the relatively distant geologic past rather than in relatively recent geologic time.

The voyage also collected a relatively large number of sediment cores from a region of the upper continental slope of New South Wales between Yamba and Byron Bay. These cores indicate that there are a relatively large number of small to medium sized landslides are present in this area; and that these landslides are probably relatively young in geological terms. The results of the voyage confirm the view that sediment transport from the shelf to deep water on this margin is controlled by gravity mass transport, resulting in a degradational margin.

The scientific objectives of the voyage were achieved with a high degree of success. The entire range of investigations into submarine landsliding and mass wasting in this geologic terrain described in this voyage's voyage proposal are all enabled by the samples and data that have been collected during the ss201_v01 research voyage and will be undertaken.

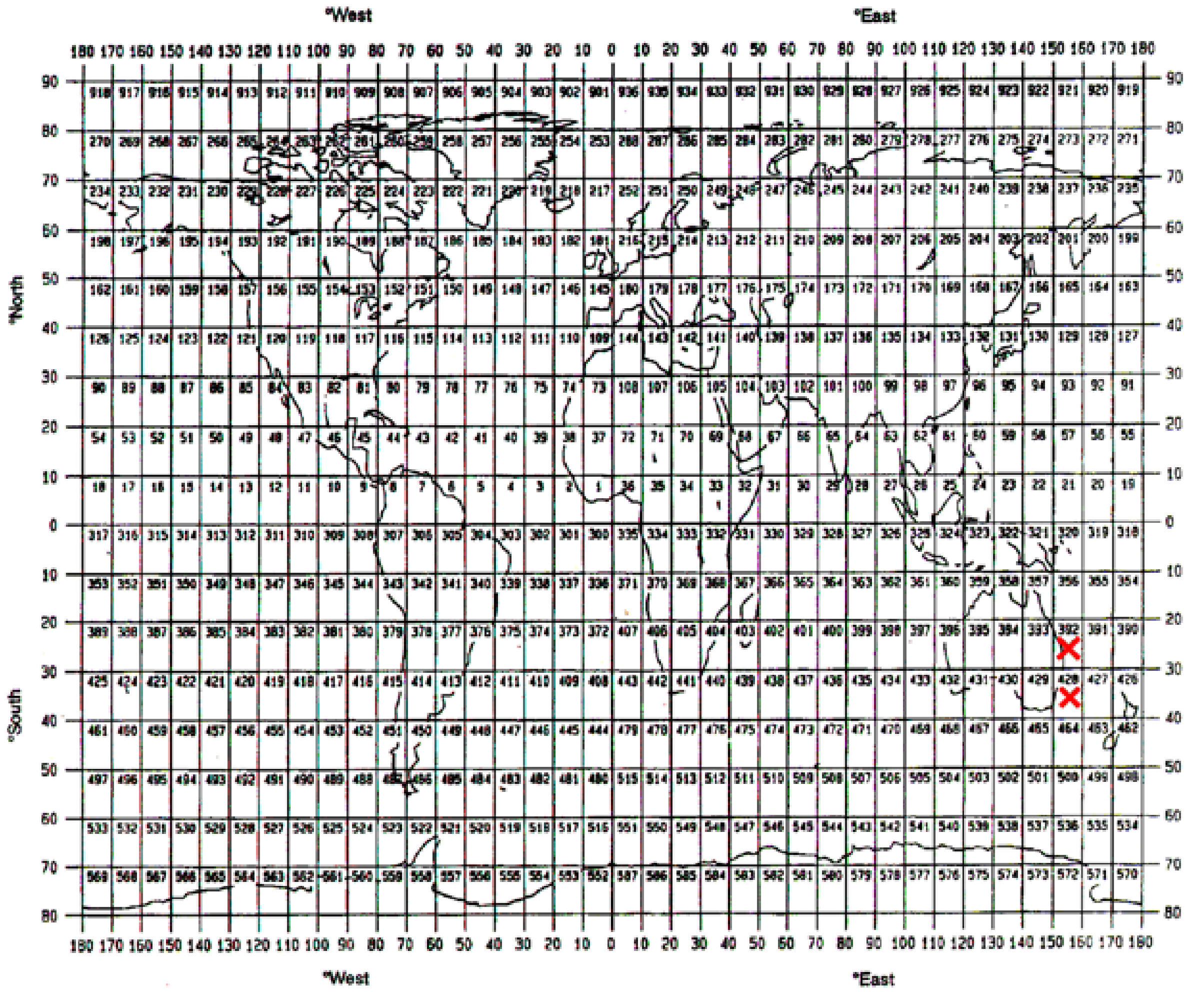
PRINCIPAL INVESTIGATORS

A. Associate Professor Tom Hubble – School of Geosciences – The University of Sydney

B. Dr Jody Webster - School of Geosciences – The University of Sydney

C. Professor David Airey – Department of Civil Engineering – The University of Sydney

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED

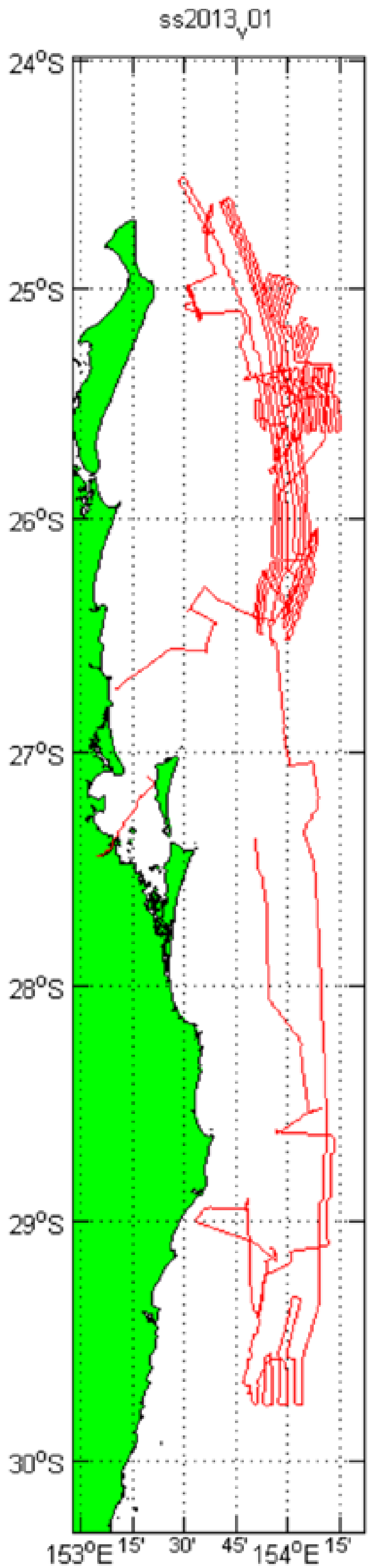


SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN					
Item No.	**PI**	**No.**	**Units**	**Data Type**	**DESCRIPTION**
1	A, B, and C	39	Gravity Core Stations	G04	Gravity Core Deployment (six metre) – station position, depth, core recovery information as well as an initial description if the core was split and logged on board ship is provided in Appendix Two. Almost all deployments were successful, three lost samples due to overfilling and failure of the core catcher. Several others recovered small samples when corer ceased penetration when hard material was encountered
2	A, B, and C	24	Box and Pipe Dredge Stations	G01	Box and pipe dredge deployment – position, depth, samples recovered as well as initial descriptions are provided in Appendix Two
3	A	2	Grab Stations	G02	Smith-MacIntyre Grab Deployment – position, depth, samples recovered as well as initial descriptions are provided in Appendix Two (both attempts were unsuccessful)
4	A	1	CTD Cast	H10	CTD001, Position 29°08.134’S, 153°56.343’E, depth 1875 metres. General Location: offshore the mouth of the Clarence River, northern New South Wales, full oceanic depth cast.
5	A and B	1	Lines	G74	Regional Multibeam Bathymetry: for location see the ship’s track plots
6	A and B	1	Lines	G75	Single Channel Sub-bottom profiles (Topas): for location see the ship’s track plot – note generally only effective on the shelf and upper slope in shallow water depths (between 30 and 1000 metres)

Curation Report

Item No.	DESCRIPTION
1	Gravity cores will be stored in the cold storage facility at the School of Geosciences, Madsen Building University of Sydney while they are described, logged and subsampled for sedimentological analysis and geotechnical testing. On final completion of geological and geotechnical testing it is intended that these samples will be transfered to the permanent curation facilities of Geoscience Australia in Canberra. It is envisioned that this transfer will take place in several years time – but the transfer should take place no later than 2020.
2	Box and pipe dredge samples will be stored in the cold storage facility at the School of Geosciences, Madsen Building University of Sydney while they are described, logged and subsampled for sedimentological analysis and geotechnical testing. On final completion of geological and geotechnical testing it is intended that these samples will be transfered to the permanent curation facilities of Geoscience Australia in Canberra. It is envisioned that this transfer will take place in several years time – but the transfer should take place no later than 2020.
3	No samples were recovered
4	This results of the CTD cast were logged digitally and the information is stored in the MNF's publically accessible digital archive at CSIRO Hobart
5	Digital multibeam echo sounder data archived in the MNF's publically accessible digital archive data base at CSIRO Hobart and by Tom Hubble and Jody Webster on permanent digital data storage facillities maintained by the University of Sydney's ICT unit.
6	Digital Topas data archived in the MNF's publically accessible digital archive data base at CSIRO Hobart and by Tom Hubble and Jody Webster on permanent digital data storage facillities maintained by the University of Sydney's ICT unit.

Voyage track chart



General ocean area(s): Tasman Sea

Specific areas: Continental shelf and slope of Northern New South Wales and Southern Queensland

Personnel list

Scientific Participants

Name	Affiliation	Role
Tom Hubble	USYD	Chief Scientist
Jody Webster	USYD	Co-Chief Scientist / Marine Geologist
David Airey	USYD	Geotechnical Engineer
Floyd Howard	GA	Geoscientist
David Mitchell	USYD	Marine Technician
Angel Puga Bernabeu	Univ of Granada	Marine Geologist
David Voelker	GEOMAR Kiel	Marine Geologist
Melissa Fletcher	USYD-student	MSc student on this project
Samantha Clarke	USYD-student	PhD student on this project
Mike Kinsela	USYD	Geoscientist
Phyllis Yu	USYD	PhD student on this project
Aaron Shorthouse	CMAR	MNF Voyage Manager
Tara Martin	CMAR	MNF Swath Mapping Support
Pamela Brodie	CMAR	MNF Computing Support / Deputy Voyage Manager
Karl Forcey	CMAR	MNF Electronics Support

Marine Crew

Name	Role
John Barr	Master
Michael Tuck	1st Officer
Tom Watson	2nd Officer
Nick Fleming	Chief Engineer
Seamus Elder	First Engineer
Graham McDougall	Boatswain
Bill Hollingworth	Second Engineer
Kel Lewis	IR
Peter Taylor	IR
Rod Langham	IR
Michael Chalk	IR
Warren Leary	Chief Cook
Jason Wall	First Cook
Charmayne Aylett	Chief Steward

Acknowledgements

The scientific party wishes to thank the Universities of Sydney and the University of Granada and GEOMAR for enabling and providing the resources for undertaking the voyage and for the MNF and CSIRO for providing us with time on the RV *Southern Surveyor*. The Master and crew of the RV *Southern Surveyor* and the MNF support staff are also thanked for providing an efficient, effective and enjoyable working environment.

Associate Professor Tom Hubble
Chief Scientist

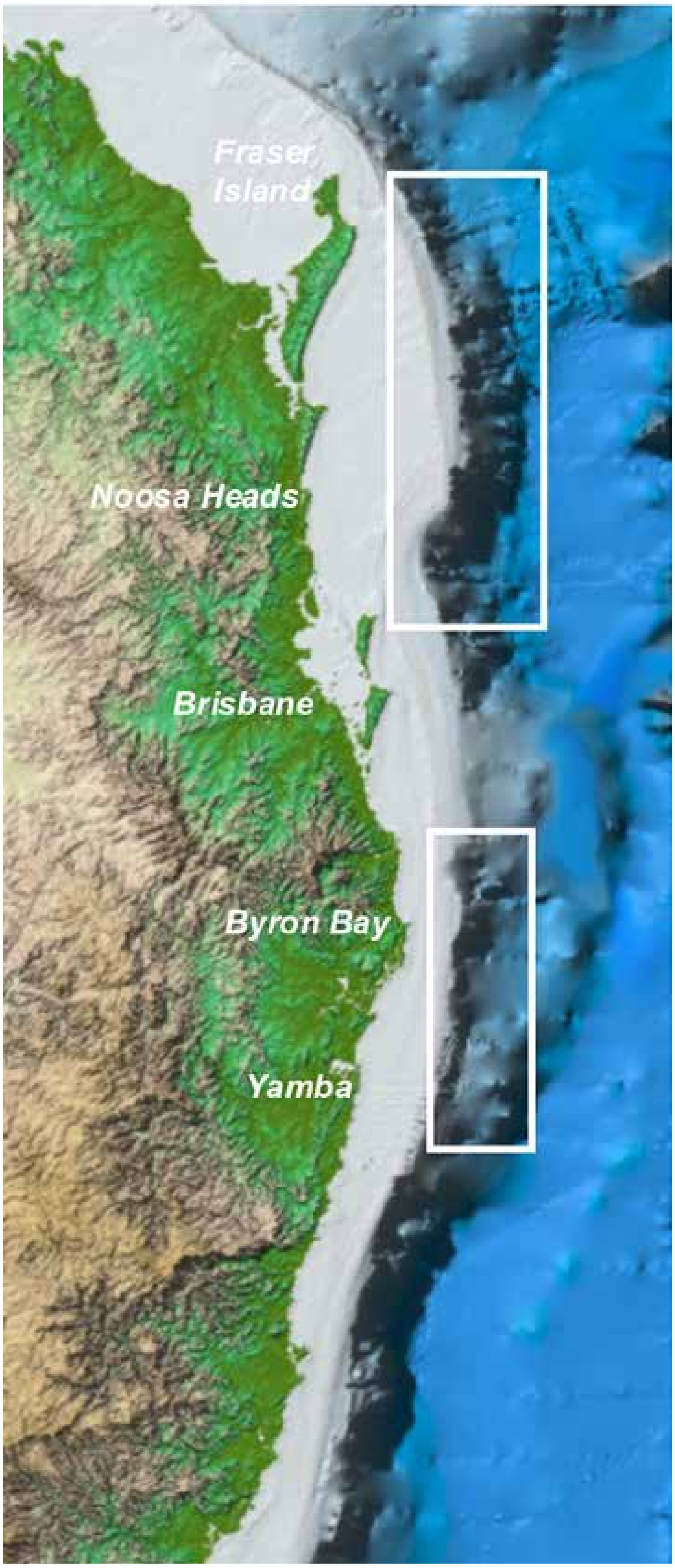


Figure 6: Main Areas of Operations – ss2013_v01, as enclosed by white boxes.

APPENDICES

Appendix 1 – Sample Locations and Descriptions

Table A2.1. Summary of gravity core deployments						
Station No.	**Gravity Core Number**	**Locality**	**Target**	**Latitude**	**Longitude**	**Actual Water Depth (m)**
1	GC001	Offshore Indian Head, Fraser Island	Near the crest of a slide adjacent to a scarp on the northern side	24°43.445S	153°36.231E	1092.30
2	GC002	Offshore Fraser Island (Sandy Cape)	Slope within box slide	24°45.116S	153°36.696E	1092.30
5	GC003	North of the Wide Bay Canyon, offshore the southern tip of Fraser Island	Within the upper portion of a slide developed in the midslope deposits on a plateau like area	25°21.187S	153°57.937E	1508.60
6	GC004	North of Wide Bay Canyon, offshore the southern tip of Fraser Island	Slope adjacent to box slide	25°20.003S	153°57.503E	1429.40
10	GC005	Wide Bay Canyon, offshore the southern tip of Fraser Island	Canyon floor, towards the mouth of Wide Bay Canyon	25°28.497S	154°06.408E	3422.00
11	GC006	Offshore Fraser Island Wide Bay Canyon	Canyon floor, mid of canyon axis	25°28.805S	154°02.292E	2926.10
12	GC007	Offshore Fraser Island Wide Bay Canyon	Canyon floor, mid of canyon axis	25°30.503S	153°58.820E	2399.00
13	GC008	Offshore Fraser Island Wide Bay Canyon	Canyon floor, below head of canyon	25°31.910S	153°57.398E	2196.60
14	GC009	Wide Bay Canyon, offshore the southern tip of Fraser Island	Spill-over splay from a small upper slope canyon incised adjacent to a crestal scarp in the northern wall of the Wide Bay Canyon	25°26.193S	153°56.215E	1214.00
15	GC010	Offshore Fraser Island	Plateau above Scarp	25°25.498S	153°55.705E	943.00
16	GC011	Offshore Fraser Island	Channel SE and adjacent to scarp	25°26.01S	153°55.987E	1180.00
28	GC012	Offshore Noosa	Just north of the Noosa Canyon head on shelf (hardgrounds?)	26°13.57S	153°53.966E	249.40
29	GC013	Offshore Noosa	Noosa Canyon floor, axis of canyon	26°19.199S	153°57.122E	2463.10
30	GC014	Offshore Noosa	Noosa Canyon floor, axis of canyon	26°20.568S	153°57.815E	2755.20
31	GC015	Offshore Noosa	Noosa Canyon floor, axis of canyon	26°22.167S	153°59.525E	2902.10
35	GC016	Yamba Plateau	Yamba Plateau slide on upper slope, within slide feature	29°42.962S	153°48.729E	1018.80
36	GC017	Yamba Plateau	Yamba Plateau slide on upper slope, within slide feature	29°41.399S	153°48.902E	970.10

Table A2.1. Summary of gravity core deployments (continued)						
Station No.	**Gravity Core Number**	**Locality**	**Target**	**Latitude**	**Longitude**	**Actual Water Depth (m)**
37	GC018	Yamba Plateau	Yamba Plateau slide on upper slope, within slide feature	29°40.995S	153°47.287E	730.30
38	GC019	Yamba Plateau	Yamba Plateau reference core(?), adjacent to slide feature (actually in small slide feature)	29°40.358S	153°47.029E	652.10
39	GC020	Offshore Clarence	Within slide feature on the upper slope	29°34.800S	153°48.565E	731.80
40	GC021	Offshore Freeburn Rock	Within slide feature on the upper slope	29°32.093S	153°48.973E	709.00
41	GC022	Offshore Freeburn Rock	Within slide feature on the upper slope	29°28.716S	153°49.988E	863.60
42	GC023	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°25.476S	153°51.576E	983.40
43	GC024	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°24.213S	153°51.344E	884.30
44	GC025	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°23.275S	153°51.192E	763.50
45	GC026	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°20.917S	153°51.984E	839.00
49	GC027	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°23.304S	153°51.202E	763.90
50	GC028	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°16.370S	153°52.862E	1000.48
51	GC029	Offshore Clarence Head (Clarence River)	Within slide feature on the upper slope	29°14.669S	153°53.087E	956.10
52	GC030	Clarence Canyon	Top of slide block at the base of the Clarence Canyon	29°10.414S	154°00.983E	2299.00
54	GC031	Byron Slide, offshore Byron	Within slide feature on the upper slope	28°37.468S	153°56.817E	893.20
55	GC032	Byron Slide, offshore Byron	Within slide feature on the upper slope	28°36.793S	153°56.418E	734.00
56	GC033	Byron Slide, offshore Byron	Within slide feature on the upper slope	28°36.807S	153°56.406E	731.30
57	GC034	Byron Slide, offshore Byron	Within slide feature on the upper slope	28°36.894S	153°57.206E	977.20
58	GC035	Byron Slide, offshore Byron	Within slide feature on the upper slope	28°36.686S	153°57.887E	1072.60
59	GC036	Tweed Canyon	Within cayon axis	28°31.140S	154°09.739E	3065.00
60	GC037	Tweed Canyon	Within cayon axis	28°31.762S	154°06.254E	2784.00
62	GC038	Offshore Noosa - Barwon Bank	Barwon Bank	26°23.834S	153°47.192E	131.70
63	GC039	Offshore Noosa - Barwon Bank	Barwon Bank	26°23.693S	153°46.857E	128.20

Table A2.2. Summary of sediment gravity core recovery							
Station No.	**Gravity Core Number**	**Total Recovery (m)**	**Penetration (m)**	**No. of sections**	**Onboard Analysis**	**Stratigraphy**	**Comments (e.g. recovery/lithology)**
1	GC001	1.33	1.5	2	Split, logged	4 units	Core: 1.33 m long: yellow-brown sand grading into orange brown sandy mud at the surface (to 0.4m); light olive grey mud (0.4m to 1.2m) and stiff sand (1.2 m to 1.3 m). Ships geologists initially identify the materials as a turbidite (top of core), hemipelagic, bioclastic (with foraminifera dominant) mud, and slope sand (base of core). Note the 'turbidite'graded sand eroded into or deposited onto the hemipelagic slope muds and the stiff coarser sandy on which the hemipelagic muds are deposited - the contact between the two units presents core artefacts or apparent load.
2	GC002	5.71	6+	6	Not split	-	6 m long medium to dark grey and slightly olive grey sandy-silty-mud and clay (this core not split). Near full recovery.
5	GC003	3.62	6	6	Split, logged	Single conformable section	Core: 3.62 m long generally homogenous, hemipelagic, bioturbated, bioclastic, grey and slightly olive grey sandy-silty-mud. The sandy material is comprised of foraminifera, shell fragments and other carbonate detritus. The whole unit is faintly laminated, probably due to burrowing. Black flecks of organic (?) matter down the whole core (small amounts). Fe oxide staining near the surface (~21 cm depth). Note: the undisturbed triaxial samples were cut from this core (unsplit sections).
6	GC004	0.42	1.5	1	Not split	-	Low penetration and recovery. Firm sandy mud, compacted and dry in parts. Core cutter full - sample pushed through to upper section.
10	GC005	1.95	0.48	2	Split, logged	4 units	Penetration on core barrel only 0.48 m despite returning ~2 m of core. Bottom 0.1 m of core 1B empty/lost in core catcher on way out of section. 1B is <1 m in length. Top of core was foraminifeous mud of sand size, quite abudant. Section between 1B and 2A contained adundant terapod fossils. A 1.95 m long core: **Unit 1**: oxidised surface layer of yellow-brown sand grading into greyish yellow, bioclastic, foraminiferal sandy mud at the surface (to 0.1m) Unit 2: light yellow mud fine sands (0.1 m to 0.52 m) moving to yellowish grey coarse sand (0.52 m to 0.68 m) - fining upwards. Sandy material is comprised of foraminifera, shell fragments and other carbonate detritus. **Unit 3**: grey to greyish olive hemipelagic silty clays with mottling and black flecks (organics?) (0.68 m to 0.89 m). Faint mottling is evident. The sediment is dominantly biogenic carbonate mud, with some terrigenous silt and clay. **Unit 4**: light grey to grey coarse to very coase sands with possible load stucture and black discolouration at boundary, sheel frags, spines, gastropods etc throughout layer (0.89 m to 1.18 m)

Table A2.2. Summary of sediment gravity core recovery (continued)							
Station No.	Gravity Core Number	Total Recovery (m)	Penetration (m)	No. of sections	Onboard Analysis	Stratigraphy	Comments (e.g. recovery/lithology)
10	GC005	1.95	0.48	2	Split, logged	4 units	**Unit 5**: Grey mottled hemipelagic silty clays (1.18 m to 1.68 m), band of black (organic??) matter ~1mm thick at 1.47 m - possible erosion surface? The laminations present as very faint horizontal stripes but in general it is difficult to detect obvious grainsize variation within laminae or between laminae. This unit is mildly to moderately bioturbated which has tended to homogenise the sediment. **Unit 6**: Hemipelgic grey to olive grey muds (1.68 m to 1.95 m). Less silty than above units, with 4+ blocks(?) distinguished by colour changes at random orientations within the unit. Note the two 'turbidites' (normally graded sands eroded into or deposited onto the hemipelagic slope muds and the two distinct stiff mud layers evident at the base of the core.
11	GC006	1	3.5	1	Not split	-	A one metre long core. Grey mud at base is recovered.
12	GC007	catcher	0.2	0	NA	Surface sample, no stratigraphy	Corer penetrated surface only to depth of catcher - firm compacted sandy mud extracted from core cutter. Winch operator suspects corer fell on side after lodging in seabed. Core cutter, catcher and top of core (surficial) samples returned. Core catcher contains 10 cm thick jammed in sample of compacted mid-slope stiff mud.
13	GC008	0.83	2	1	Not split	-	A 0.83 metre long core of yellow brown sandy mud on upper core, core penetration ceased in firm medium grey clay unit.
14	GC009	4.7	5	5	Split		A 4.7 metre long core: 30 cm thick normally graded foraminferal sand at the top of the core which overlies a stiff medium grey, bioclastic, silty mud and several, separate approximately 0.7 metre thick, different coloured mud layers. The sandy material is comprised of foraminifera, shell fragments and other carbonate detritus. Probably a turbidite that has spilled over the channel margin. Note the 'turbidite' graded sand eroded into or deposited onto the hemipelagic slope muds.
15	GC010	4.35	4.5	5	Not split	NA	Good penetration and recovery. Nil core catcher. An approximately five metre long core is recovered. Details to be provided on splitting.
16	GC011	2.79	6+	3	Not split	NA	6+ m penetration - weight disc and entire barrel covered with mud. Core catcher medium grey stiff mud. An 2.79 metre long core is recovered. Details to be provided on splitting.
28	GC012	0	0	0	No return	NA	No return in core. Located above carbonate hardgounds(?) so not unexpected. Heavy swell, may have landed on side or hard ground.
29	GC013	0.9	1	1	Not split	NA	Core catchers: saved for goetech sample. Dark olive grey semi comsolidated muds. Low sand content in the cc. Hemipelagic silts/ clays. Small subsample of cc taken in bag.

Table A2.2. Summary of sediment gravity core recovery (continued)							
Station No.	Gravity Core Number	Total Recovery (m)	Penetration (m)	No. of sections	Onboard Analysis	Stratigraphy	Comments (e.g. recovery/lithology)
30	GC014	0	0	0	NA	Cutter sample only	Volcanoclastics and basalt gravel fragments retrieved from core cutter. Some organics including gastropod and bivalve speciments. Biogenic material extracte and taken as sub sample. 2 jars - 1 x biogenics, 1 x volcanoclastics
31	GC015	3.87	3+	4	Not split	NA	First attempt did not hit the bottom. Second attempt: approximately 3 m penetration suggested by mud on core barrel. Firm grey mud in core catcher and cutter.
35	GC016	2.11	2.2	3	Split	2 units	Core catcher and cutter full of light grey stiff mud. Appears much stiffer than previous core sites. Geotech (vane shear) performed on core catcher sample. Some silt/sand fractions but majority stiff clays. Top section of core softer than bottom. Suspected slide surface. Boundary surface seem in split core.
36	GC017	2.33	2.4	3	Not split	NA	Core catcher and cuter returned light grey sandy clay silt. Not as stiff as GC016. More forams in catcher sediments. Silt content higher.
37	GC018	4.11	5	5	Not split	NA	Core catcher sample dark grey silty clay with low silt content. Little sand fraction.
38	GC019	5.32	6+	6	Not split	NA	Subsamples taken.
39	GC020	2.63	3	4	Not split	NA	
40	GC021	1.34	unknown	2	Not split	NA	Firm grey mud in core catcher; no obvious evidence of penetratin past 1 m. Echinoderm spine in catcher sample (placed in sample jar for dating)
41	GC022	4.18	5	5	Not split	NA	Firm grey mud in core catcher; brown hydrous mud on surface.
42	GC023	5.5	6+	6	Not split	NA	Medium grey mud firm at base, hydrous at surface with brown colouring.
43	GC024	5.5	6+	6	Not split	NA	Olive grey mud - firmer at the base.
44	GC025	-	-	-	-	-	Failed - core catcher returned damaged. Evidence core was captured. Perhaps lost in contact with core cradle.
45	GC026	4	~4	4	Not split	NA	Brown soft muds at top; stiff grey mud at bottom.
49	GC027	4.72	~4	5	Not split	NA	Firm grey mud at base, oxidised hydrous layer at surface - brown in colour.
50	GC028	5.13	5	6	Not split	NA	Multi-beam depth out - used ships depth sounder. Medium grey firm mud in core catcher.
51	GC029	5.64	6+	6	Not split	NA	Medium grey mud semi firm at catcher.
52	GC030	-	-	-	No return	-	Core catcher penetrated <30 cm of material. Noth consolidated sediments and loose surfical material were preserved in core cutter and catcher/ Entire sample curated with catcher and cutter in place. Small amount of surfical sample also recovered in lower most section of core barrel. 2 bottles of surficial material from barrel and cutter & catcher sample.

Table A2.2. Summary of sediment gravity core recovery (continued)							
Station No.	Gravity Core Number	Total Recovery (m)	Penetration (m)	No. of sections	Onboard Analysis	Stratigraphy	Comments (e.g. recovery/lithology)
54	GC031	1.8	2	2	Not split	NA	Core catchers: stiff grey slightly sandy silty clay. Sand fraction composed of foram sand & shell material.
55	GC032	0	2	-	No return	-	Core was empty. Core catcher failed - too much weight? Some medium grey semi stiff mud with gritty tetrapod and shell fragment stuck to outide of core cutter. Not enough to keep.
56	GC033	0	2.5	-	No return	-	Evidence of full capture, core catcher material broken and evidence of core was lost following capture. Olive-grey firm mud around outside of core cutter.
57	GC034	3.83	3.4	4	Not split	NA	Medium grey firm mud at base, oxidisd at top, little silt.
58	GC035	1.77	2	2	Not split	NA	Core catcher: stiff grey silty mud/clay. Some foram sand but mostly stiff clay material. Top of core is oxidised brown sandy muddy silt.
59	GC036	0.44	6+	1	Not split	NA	Core catcher: stiff grey mud. Very low silt/sand content. Top section of core brown oxidised mud.
60	GC037	0	2	0	NA	NA	Small amount of olive grey mud above core catcher. Penetration suggests sample lost although catcher returned in tact.
62	GC038	0.19	?	1	Not split	NA	Wire out not working. Medium to coarse predominantly biogenic sands, grey in colour. Coarser material in catcher at base of core.
63	GC039	-	-	-	No return	-	No recovery.

Table A2.3 Summary of dredge deployments									
Station No.	**Dredge Number**	**Locality**	**Target**	**Latitude (on bottom)**	**Longitude (on bottom)**	**Actual Water Depth (m) (on bottom)**	**Latitude (start up)**	**Longitude (start up)**	**Actual Water Depth (m) (start up)**
3	DR001	Offshore Fraser Island (Sandy Cape)	Northern sidewall box slide	24°44.571′	153°34.720′	646	24°44.569′	153°34.709′	572.6
4	DR002	Offshore Fraser Island	Northern sidewall potenital slide(?)	24°38.966′S	153°37.935′E	1935.2	24°38.676′S	153°37.988′E	1668.7
7	DR003	Offshore Fraser Island	Dredge was conducted to the north west; directed up the maximum slope of the canyon wall across the 'surface' of a suspected large slide.	25°26.822′S	154°00.304′E	2272	25°26.804′S	154°00.242′E	2162.4
8	DR004	Offshore Fraser Island	Dredge was conducted to the north west; directed up the maximum slope of the canyon wall across the 'surface' of a suspected large slide.	25°26.600'S	153°58.610′E	1784.5	25°26.421'S	153°58.478′E	1703.4
9	DR005	Offshore Fraser Island	Dredge was conducted to the north; directed up the maximum slope of the crestal canyon wall and then across the adjacent slope 'surface'. The dredge probably hooked up on a ledge at the top of the crestal scarp structure which is undoubtedly represented in the drege haual by the sandstone block and the other well-lithified materials	?	?	?	25°24.722'S	154°00.002′E	1800
17	DR006	Offshore Fraser Island	North wall of Wide Bay canyon slide (between GC11 and GC11)	?	?	?	25°25.840'S	153°55.941′E	962
18	DR007	Offshore Fraser Island	Head wall of potential slumping feature on the upper slope	25°22.848'S	153°51.038'E	461	25°22.529'S	153°50.791′E	382
19	DR008	Wide Bay	North side wall of slide feature on slope between Wide Bay canyon and Tin Can canyon	25°35.416'S	153°58.505'E	1192.7	25°35.115'S	153°58.421′E	1223.5

Table A2.3 Summary of dredge deployments (continued)									
Station No.	Dredge Number	Locality	Target	Latitude (on bottom)	Longitude (on bottom)	Actual Water Depth (m) (on bottom)	Latitude (start up)	Longitude (start up)	Actual Water Depth (m) (start up)
20	DR009	Wide Bay	Within slide feature on slope between Wide Bay canyon and Tin Can canyon	25°36.516'S	153°59.033'E	1514.7	25°36.415'S	153°58.827'E	1424
21	DR010	Wide Bay	Head wall of slide feature on slope between Wide Bay canyon and Tin Can canyon	25°38.696'S	153°56.982'E	1092.5	25°38.493'S	153°56.887'E	996.4
22	DR011	Wide Bay	Head wall of slide feature(?)/developing canyon on slope between Wide Bay canyon and Tin Can canyon	25°43.260'S	153°57.117'E	1270	25°42.605'S	153°56.880'E	880
23	DR012	Wide Bay	North wall of Tin Can canyon	25°47.413'S	153°54.848'E	524	25°47.147'S	153°54.714'E	358
24	DR013	Wide Bay	North wall of Tin Can canyon	25°47.820'S	153°55.075'E	790	25°47.690'S	153°53.024'E	353
25	DR014	Wide Bay	Within slide feature on slope between Wide Bay canyon and Tin Can canyon	25°38.107'S	154°01.602'E	2069	25°37.843'S	154°01.560E	1843.5
26	DR015	Wide Bay	Within slide feature on slope between Wide Bay canyon and Tin Can canyon	25°38.595'S	154°03.176'E	2514	25°38.082'S	154°03.228'E	2357
32	DR016	Noosa Canyon	Slope on northern axis of Noosa Canyon	26°19.119'S	154°00.410'E	2210.2	26°18.964'S	154°00.395'E	2051.6
33	DR017	Sth Noosa Canyon (Bribie Slope)	Slumps scarps on slope below Bribie Bowl slide	26°27.218'S	153°54.327'E	1300	26°26.942'S	153°54.326'E	1352
34	DR018	Sth Noosa Canyon (Bribie Slope)	Slumps scarps on slope below Bribie Bowl slide	26°31.882'S	153°55.378'E	1400	26°31.486'S	153°55.507'E	1400
46	DR019	Offshore Clarence Had (Clarence River)	Slump scarp below Clarence Canyons	29°10.939'S	153°53.873'E	1326	29°10.607'S	153°53.629'E	1102
47	DR020	Offshore Clarence Had (Clarence River)	Slump scarp below Clarence Canyons	29°07.146'S	153°55.698'E	1534	29°06.671'S	153°55.304'E	1317.3

Table A2.3 Summary of dredge deployments (continued)									
Station No.	**Dredge Number**	**Locality**	**Target**	**Latitude (on bottom)**	**Longitude (on bottom)**	**Actual Water Depth (m) (on bottom)**	**Latitude (start up)**	**Longitude (start up)**	**Actual Water Depth (m) (start up)**
53	DR021	Byron Slide, Offshore Byron	Scarp at the base of the Byron slide	28°37.234'S	153°58.268'E	1312.8	28°36.863'S	153°57.966'E	1126
64	DR022	Barwon Bank, Offshore Noosa	Dune feature in Barwon Bank region	26°21.244'S	153°41.465'E	93.8	26°21.238'S	153°41.395'E	98.1
65	DR023	Barwon Bank, Offshore Noosa	Dune feature in Barwon Bank region	26°24.640'S	153°34.636'E	69.6	26°24.735'S	153°34.672'E	63.6
66	DR024	Barwon Bank, Offshore Noosa	Dune feature in Barwon Bank region	26°24.887'S	153°35.077'E	71.6	26°24.802'S	153°34.006'E	63.9

Table A2.4 Summary of Dredge Samples Retrieved			
Station No.	**Dredge Number**	**Total Recovery**	**Comments (e.g. recovery/lithology)**
3	DR001	0.5 m^3	Dredge: light yellow grey sandy muds in pipe dredge with a ~1 kg angular squarish block of yellow to pink phosphatite (probs micro-fossil besring) & hard. Phosphorite - hard rock, light greyish yellow to pink phosohatised sediment
4	DR002	~30 kg	3 lithofacies identified. Dredge: excellent recovery of compacted sandy muds 30kg (Boyd et al midslope materials) and one sample each (~1/2 kg) of partly lithified sandy mudstone and a chalky white mudstone. Pipe dredges both full of unconsolidated hemipelagic foraminferal sandy mud.
7	DR003	0	No recovery in dredge – all dredges bright and clean. Suspect that the dredges have encountered loose sand.
8	DR004	4 m^3	Dredge: excellent recovery of compacted sandy muds 200 kg in total of which about 80 kg was returned to the ocean (very similar to the softer of the Boyd et al midslope materials) and one sample (~1/4 kg) of \ well-lithified medium-grained, well-sorted, light-greyish yellow sandstone. Pipe dredges both full of unconsolidated, very lightgrey (with an olive tinge) hemipelagic foraminferal sandy mud.
9	DR005	~100 kg 1 x nally bin (chain bag) 1 x bucket (mesh and closed pipe)	Dredge: excellent recovery of a large 10 kg slab of well-lithified sandstone (last sample in the dredge), and several sandstone and siltstone cobbles a range of hard stiff to soft compacted sandy muds 100 kg – this very similar to the the Boyd et al midslope materials). Pipe dredges both full of unconsolidated, very light-grey (with an olive tinge) hemipelagic foraminferal sandy mud. Consolidated muds (with Mg crust and burrows) and deep water coral crust
17	DR006		Good recovery of sandstones, siltones and stiff muds. Pipe dredges also yield yellowish-grey sandy muds.Sandstone ith Mg crust, featuring many bore holes and organics (hard surface at lip of slide scar?)
18	DR007	~30 kg	Excellent Recovery of approximately 20 to 30 kg of phosphatised and dolomitised grainstones (reefal shallow-water carbonates with abundant benthic forams of probable late Miocene age). Mn crusted limestone, with foram fossils, shells etc - possible Miocenc limestone (?)
19	DR008	1 x nally bin & 2 x bucket (chain bag) 1 bucket (pipes)	Excellent recovery in all three dredges. The box dredge and open pipe dredge yields a number of manganese and carbonate encrusted stiff sandy muds with deep-water coral ‘hold fasts’ present in the carbonate encrustations with an almost entire deepwater coral included in the dredge haul. Fine grained calcarenite (bubbled under HCl) and consolidated muds (pale offwhite to grey-yellow). An entire brittle star is also recovered and preserved in formaldehyde for delivery to colleagues in Marine Biology
20	DR009		Box dredge empty but cleaner up and bright. Pipe dredges return light yellowish grey sandy mud.
21	DR010		Good recovery of compacted sandy muds (very similar to the softer of the Boyd et al midslope materials). Pipe dredges both full of unconsolidated, very light-grey (olive tinge) hemipelagic foraminferal sandy mud.
22	DR011		Good recovery of compacted sandy muds (very similar to the softer of the Boyd et al midslope materials), some with Fe coating and boreholes. Pipe dredges both full of unconsolidated, very light-grey (with an olive tinge) hemipelagic foraminferal sandy mud.
23	DR012		Good recovery of unconsolidated sandy muds lumps filled one third of the bag of the dredge. The pipe dredges full of unconsolidated, light orange brown hemipelagic foraminferal sandy muds.
24	DR013		Good recovery of unconsolidated sandy muds lumps filled one third of the bag of the dredge. The pipe dredge dredges full of unconsolidated, light orange brown sandysilty clay hemipelagic foraminferal sandy muds.
25	DR014	200 kg	Excellent recovery (dredge’s chain bag 2/3 full) of compacted sandy muds (very similar to the softer of the Boyd et al midslope materials) – some blocks weigh 30+ kg.
26	DR015		Pipe dredges both full of unconsolidated, very light-grey (with an olive tinge) hemipelagic foraminferal sandy mud.
32	DR016		Good recovery of compacted sandy muds (similar to DR014) Pipe dredges both full of unconsolidated, very light-grey (with an olive tinge) hemipelagic foraminferal sandy mud. A 1kg lump of compacted mud is also recovered

Table A2.4 Summary of Dredge Samples Retrieved (continued)			
Station No.	**Dredge Number**	**Total Recovery**	**Comments (e.g. recovery/lithology)**
33	DR017		EM300 & 12 khz not working during dredge
34	DR018		EM300 & 12 khz not working during dredge
46	DR019		No obvious tension spikes
47	DR020	1m^3	Several tension spikes up to 3 tn. Unconsolidated-semiconsolidated mud
53	DR021		
64	DR022	2 pieces	Dredge caught on bottom. Cemented medium to coarse sand with coarser pebbles in layers and generally throughout. Organics on cements surface indicate seafloor
65	DR023		Fine sandstone heavily encrusted with corals, bryozoa, encrusting algae. Echinoderms and crustacea. Coarse sand in closed pipe with sandstone. Mesh pipe: assorted sandstone rocks. Chain bag returned torn with one rock
66	DR024	10-20 kg	10-20 kg of dark to light yellow sand with lots of shelly fragments. 1 nally bin full of coral material (living coat of reef). Chain bag contained corals, bryozoa, sea stars, sea fans. Closed pipe and mesh pipe contained muddy sands with shelly fragments

Table A2.5 Summary of grab deployments							
Station No.	**Grab Number**	**Locality**	**Latitude**	**Longitude**	**Actual Water Depth (m)**	**Total Recovery**	**Comments (e.g. recovery/lithology)**
27	1	Shelf edge above Noosa Canyon	26°13.699′	153°53.126′	258.8	None	Four attempts - none successful. Wire out and speed not working. Strong current & may also have not landed flat
61	2	Shelf edge above Noosa Canyon	26°24.284′	153°47.235′	132.1	None	Wire out not working

Table A2.6 Summary of CTD deployments							
Station No.	**CTD Number**	**Locality**	**Latitude (start)**	**Longitude (end)**	**Latitude (start)**	**Longitude (end)**	**Actual Water Depth (m)**
48	CTD001	Offshore Clarence River	29°08.134′S	153°56.343′E	29°08.832′S	153°56.524′E	1872

CSR/ROSCOP PARAMETER CODES

METEOROLOGY

M01 Upper air observations
M02 Incident radiation
M05 Occasional standard measurements
M06 Routine standard measurements
M71 Atmospheric chemistry
M90 Other meteorological measurements

PHYSICAL OCEANOGRAPHY

H71 Surface measurements underway (T,S)
H13 Bathythermograph
H09 Water bottle stations
H10 CTD stations
H11 Subsurface measurements underway (T,S)
H72 Thermistor chain
H16 Transparency (eg transmissometer)
H17 Optics (eg underwater light levels)
H73 Geochemical tracers (eg freons)
D01 Current meters
D71 Current profiler (eg ADCP)
D03 Currents measured from ship drift
D04 GEK
D05 Surface drifters/drifting buoys
D06 Neutrally buoyant floats
D09 Sea level (incl. Bottom pressure & inverted echosounder)
D72 Instrumented wave measurements
D90 Other physical oceanographic measurements

CHEMICAL OCEANOGRAPHY

H21 Oxygen
H74 Carbon dioxide
H33 Other dissolved gases
H22 Phosphate
H23 Total – P
H24 Nitrate
H25 Nitrite
H75 Total – N
H76 Ammonia
H26 Silicate
H27 Alkalinity
H28 PH
H30 Trace elements
H31 Radioactivity
H32 Isotopes
H90 Other chemical oceanographic measurements

MARINE CONTAMINANTS/POLLUTION

P01 Suspended matter
P02 Trace metals
P03 Petroleum residues
P04 Chlorinated hydrocarbons
P05 Other dissolved substances
P12 Bottom deposits
P13 Contaminants in organisms
P90 Other contaminant measurements
B01 Primary productivity
B02 Phytoplankton pigments (eg chlorophyll, fluorescence)
B71 Particulate organic matter (inc POC, PON)
B06 Dissolved organic matter (inc DOC)
B72 Biochemical measurements (eg lipids, amino acids)
B73 Sediment traps
B08 Phytoplankton
B09 Zooplankton
B03 Seston
B10 Neuston
B11 Nekton
B13 Eggs & larvae
B07 Pelagic bacteria/micro-organisms
B16 Benthic bacteria/micro-organisms
B17 Phytobenthos
B18 Zoobenthos
B25 Birds
B26 Mammals & reptiles
B14 Pelagic fish
B19 Demersal fish
B20 Molluscs
B21 Crustaceans
B28 Acoustic reflection on marine organisms
B37 Taggings
B64 Gear research
B65 Exploratory fishing
B90 Other biological/fisheries measurements

MARINE GEOLOGY/GEOPHYSICS

G01 Dredge
G02 Grab
G03 Core – rock
G04 Core – soft bottom
G08 Bottom photography
G71 In-situ seafloor measurement/sampling
G72 Geophysical measurements made at depth
G73 Single-beam echosounding
G74 Multi-beam echosounding
G24 Long/short range side scan sonar
G75 Single channel seismic reflection
G76 Multichannel seismic reflection
G26 Seismic refraction
G27 Gravity measurements
G28 Magnetic measurements
G90 Other geological/geophysical measurements